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Subject: DRAFT SAMPLING PLAN TO CHARACTERIZE AREAS IN OU-1 OF THE WEST LAKE MUNICIPAL LANDFILL SITE, BRIDGETON, MISSOURI

The West Lake Municipal Landfill Site (Site) shown in Figure 1 below consists of highly radiotoxic wastes with total radium, total thorium and uranium identified as the main radionuclides (RADs) of concern. The site is surrounded by densely populated areas. Radiological materials are found at two areas (Area 1 and Area 2) of the operable unit-1 (OU-1) of the Site and at a narrow strip of an adjacent property called the "Buffer Zone/Crossroads Property". The radiological materials are mixed with landfilled refuse, debris, soil and fill, and appear in both surface (the upper six inches of ground) and subsurface (7 to 12 feet or deeper) areas of the Site. The radiologically impacted materials (RIM) consist of approximately 146,000 cubic yards of commingled refuse, debris, fill materials and soil, distributed in various quantities and concentrations across, under, and in approximately 28 acres of landfill.

The project team associated with the Site wants to develop sampling plans which can be used to characterize RIM in the two areas of concern (AOCs): Area 1 and Area 2 of the OU-1 and the associated Buffer Zone. A typical sampling plan must be correctly defined and organized in order to get an accurate estimation of the characteristics (e.g., thorium, radium) of the waste present in an area under investigation considerations (West Lake Landfill). The use of data sets of appropriate sizes and proper sampling techniques (field and laboratory) to collect representative samples (e.g., based upon simple random sampling [SRS])) is desirable. The details of the various sampling approaches (random, systematic, systematic random, composite) to collect representative samples of desired sizes meeting data quality objectives (DQOs) can be found in Cochran (1977), EPA (2000, 2002, 2006), ITRC (2012), and Gilbert (1987). ProUCL 5.0 and Visual Sampling Plan (VSP) software packages can be used to compute DQOs based minimum number of samples needed to address project objectives (e.g., estimation of mean, verification of cleanup standards etc.).

This memorandum briefly describes some sampling approaches which can be used to develop sampling designs for the two AOCs of OU-1. The details of those approaches can be provided once the project team decides about using a sampling approach most appropriate to suit their sampling needs and project objectives.

Figure 1 the West Lake Landfill

Considerable amount of data for the three RADs of concern have already been collected from surface and surface soils of the two AOCs of the Site. These data are summarized in tables of the Supplemental Feasibility Study Radiological-Impacted Material Excavation Alternatives Analysis West Lake Landfill Operable Unit-1 (SFS Report, 2011). From these data tables, it is noted that discrete samples were collected and spatial information: Easting, Northing associated with those discrete sampling locations were not recorded.

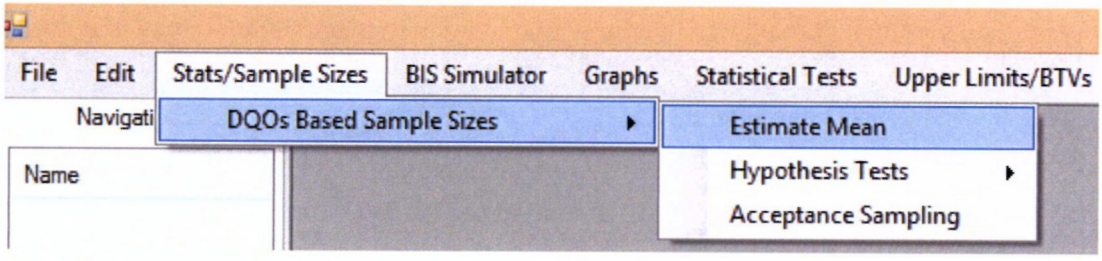
- It is suggested that all existing RAD data be made available electronically in Excel files so that all available information can be used in developing cost-effective and defensible sampling plans for the two AOCs of OU-1 and performing statistical evaluations.

Three sampling approaches (discrete, composite based upon incremental sampling methodology [ISM], and random or systematic approach following a grid pattern) which may be used to

collect additional data from the two AOCs of the OU-1 are described as follows. Sampling plans should be developed separately for the two AOCs.

Sampling Plan based upon Discrete Samples

- The first step is to state the sampling objectives so that an appropriate amount of data can be collected to address those objectives. Sample size modules are available in VSP (PNNL) and ProUCL 5.0 (EPA 2013) software packages. These software packages can be used to determine the minimum number of samples needed to address those objectives. Sample size modules require an estimate of the data variability. For the West Lake Site, the existing data can be used to compute an estimate of data variability. Based upon data variability and specified DQOs (e.g., Type I and Type II error rates, margin of error) associated with the data collection objective, one can use ProUCL/VSP to compute the minimum number of samples needed to address the sampling objective. For example, if the sampling objective is to estimate the mean concentration of the RIM present in an AOC, one can use the sample size module of ProUCL (shown below) to compute the minimum number of samples needed.



Some sampling scenarios are presented as follows:

For specified DQOs (error margin =1.5, and standard deviation (sd) estimate =4), minimum number of samples needed is 30.

	Sample Size for Estimation of Mean
	Based on Specified Values of Decision Parameters/DQOs (Data Quality Objectives)
Date/Time of Computation	1/21/2015 6:01:09 PM
User Selected Options	
Confidence Coefficient	95%
Allowable Error Margin	1.5
Estimate of Standard Deviation	4

	Approximate Minimum Sample Size
95% Confidence Coefficient	30

For specified DQOs (error margin =1.5, and sd estimate =6), the minimum number of samples needed is 64.

A	B	C	D	E	F	G	H	I	J	K	L
			Sample Size for Estimation of Mean								
			Based on Specified Values of Decision Parameters/DQOs (Data Quality Objectives)								
		Date/Time of Computation	1/21/2015 5:52:47 PM								
		User Selected Options									
		Confidence Coefficient	95%								
		Allowable Error Margin	1.5								
		Estimate of Standard Deviation	6								
				Approximate Minimum Sample Size							
		95% Confidence Coefficient		64							

As noted earlier, some data have already been collected (tables in SFS, 2011); one can use those existing data to satisfy the minimum number of observations needed to estimate the mean of RIM in an AOC. For example, if 35 observations have already been collected in the previous sampling events (e.g., collected using SRS- assumed), one may need to collect an additional 29 (=64-35) samples following a simple random sampling pattern. Some details of these sample size requirements can be found in ProUCL 5.0 Technical Guide (EPA 2013) and in Gilbert (1987).

For the present site, there are 3 RADs of concern. The use of the sample size module on the 3 RADs will yield different minimum sample sizes. Following the process described above and using the existing data, one can compute the number of samples needed for each of the 3 RADs. To accommodate all three RADs, one can collect the maximum (of the 3 sample sizes) number of new samples from unsampled locations of the AOC.

Note: A typical data set obtained using a discrete sampling plan tends to exhibit higher variability, especially when the sample areas are heterogeneous with respect to contaminant distribution as well material distribution. However, discrete data can be used to compute the mean as well as for characterization purposes. Moreover, since the existing data are discrete, the new and old data sets will be compatible and can be combined together for all future statistical evaluations.

Incremental Sampling Methodology (ISM) Based Approach

If the project team decides to use the ISM approach (ITRC, 2012), more information including the detailed maps of the two AOCs will be needed. The two AOCs will be sub-divided in several decision units (DUs) of roughly same size, and ISM samples will be collected from those DUs. The detailed sampling plan based upon this approach can be discussed later if the project team decides to collect samples using the ISM approach.

Note: The existing data summarized in tables of the SFS Report (2011) are collected using discrete samples; therefore the existing discrete and the composite ISM data will not be compatible. The two data sets cannot be combined together to perform further statistical evaluations. The ISM data can only be used to compute mean estimates of the AOC. ISM data does not capture spatial information and therefore cannot be used for characterization purposes

(e.g., delineating clean and polluted areas of an AOC). Also, not many (if any) analytical laboratories are equipped for analyzing RAD samples collected using the ISM approach.

Sampling Plan to for Geostatistical Methods - Kriging Approach

Data are collected using a grid pattern (random or systematic). Kriging (Isaaks and Srivastava, 1990) approach is specifically used when the objective is to characterize contaminant distribution within an AOC. The kriging approach estimates concentrations at unsampled locations based upon the concentrations observed at the neighboring locations. The use of this approach requires spatial information about the sampling locations (Easting, Northing coordinates). From tables of the SFS Report (2011), it is noted that the spatial information about the sampling locations of discrete data presented in those tables is not provided. If the project team can assign spatial information to the sampling locations of the existing data, this approach may be the best approach for characterization of the RAD distribution within the two AOCs of the OU-1.

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